Space Weather Technical Forecast

Issued on Monday, 16 May 2022 at 13:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of R1-R2 radio blackouts. Chance of G1/Minor Storms, most likely late day 3 (18th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with a C5.6 flare at 16/1004 UTC from an active region on northeast limb, with no visible sunspot. There are six numbered and two un-numbered sunspots on the visible disc. AR3007 Esi/Beta continues as the largest and most complex area, with some minimal growth observed, with all other visible regions remaining small and stable. Some minimal growth has been observed in AR3014 Dao/Beta in the northeast. There remain numerous small filaments on the disc however no Earth-directed Coronal Mass Ejections (CMEs) have been observed in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE and DSCOVR at L1, was elevated between 500 and 600km/s. The density of the wind was around average. The Interplanetary Magnetic Field (IMF) Bt, was Weak to Moderate, ranging 6nT to 10nT. The north-south component showed fluctuating periods of north/south orientation, between +8 and -7nT, but was more frequently positive (northward) orientated. The phi angle was mostly positive (away from the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 1 to 3).

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) has been at Background levels through the last 24 hours. The high energy electron flux (greater than 2 MeV) has remained predominantly at background levels, with the corresponding electron fluence well below the Active (1e8 integrated pfu) threshold on a current level trend. Observed fluence at 16/0000 UTC was 1.18e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to remain at Low to Moderate levels, with M-class flares becoming slightly more likely over the next few days owing to potentially further active regions rotating around the northeast limb, and a Slight Chance (5%) of an X-class flare.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Current elevated solar winds are expected to decline from day 2 (17th) onward, with the next notable enhancement from the arrival of the fast wind of CH82/-. This is currently expected late on day 3 (18th), however this is a low confidence forecast. Geomagnetic activity is currently Quiet with isolated Unsettled spells, and a slight chance of Active day 1 (16th), becoming mainly Quiet from day 2 (17th). Activity will likely increase to Unsettled to Active with a chance of G1/Minor Storms, from any coronal hole arrival, most likely on day 3 (18th).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is expected to be at background levels during this period, although there is a very slight risk of an S1 or greater event due to AR3007. The high energy electron flux (greater than 2 MeV) is forecast to remain at Normal Background to Moderate levels at first, but may rise over the next few days, with an increased chance of the diurnal peak reaching High levels, mainly day 4 (19th) due to any fast wind arrival on day 3 (18th). The 24-hour electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold during the forecast period.

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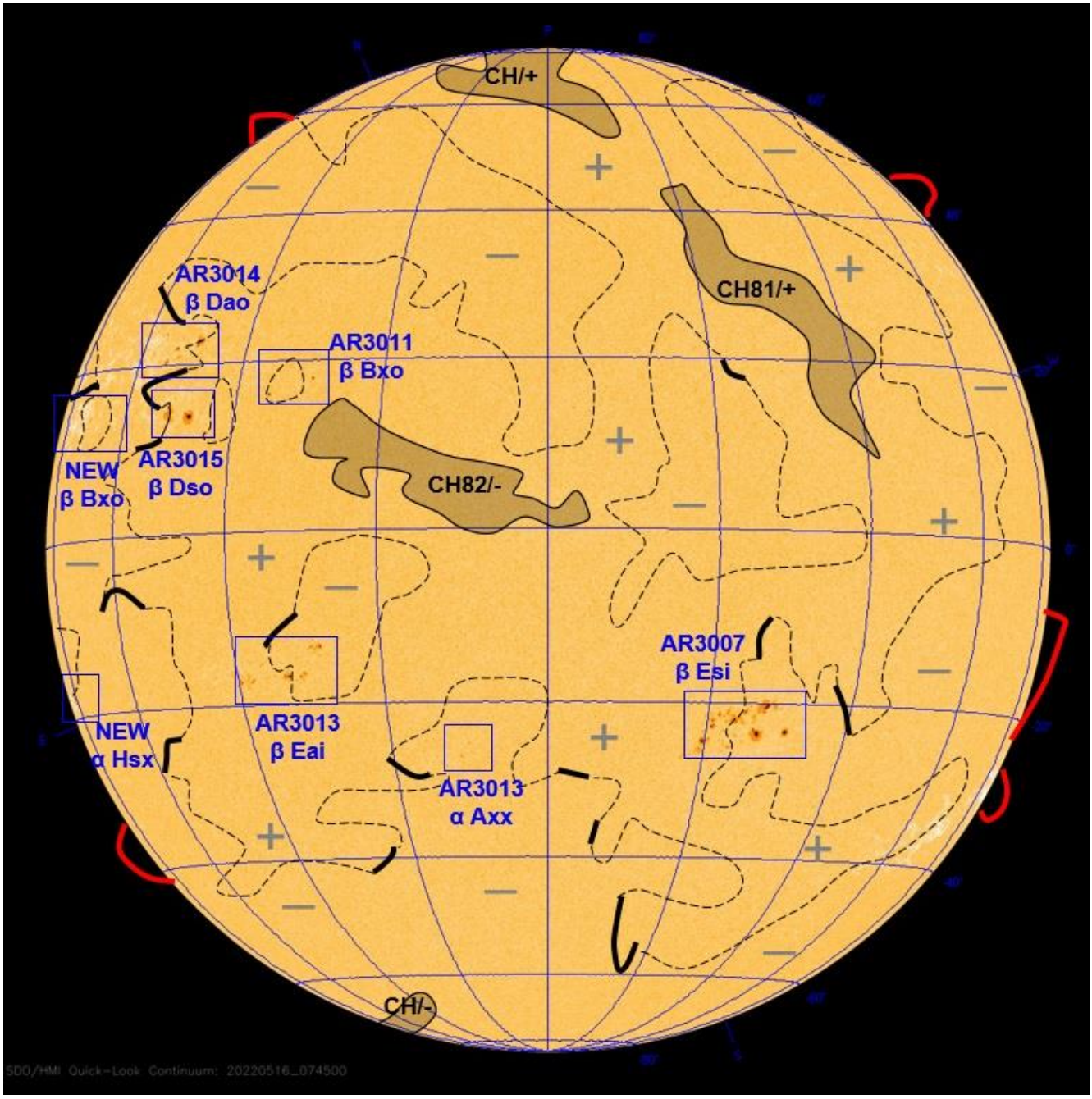
Figure 1. Solar Analysis Valid 16/0800.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-bound Coronal Mass Ejections (CMEs)

Solar winds are currently Elevated with Earth moving through the fast wind of positive polarity CH81. These elevated winds are expected to gradually ease day 2 (17th) onward, before the arrival of the fast wind of CH82/-. This is an equatorial hole, and significantly more eastward extended than on the previous rotation. Solar wind persistence would suggest a weak arrival on day 4 (19th), whilst enlil is currently indicating arrival either late day 2 or day 3 (17th or 18th). Arrival late 18th is currently favoured, but low confidence.

Geomagnetic activity is currently Quiet with isolated Unsettled spells, and a slight chance of Active day 1 (16th), becoming mainly Quiet from day 2 (17th). Arrival of fast winds of coronal hole 82 will then increase activity to Unsettled to Active with a chance of G1/Minor Storms, most likely on day 3 (18th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	30	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: SDO aia 193 showing change of CH structure on this rotation.

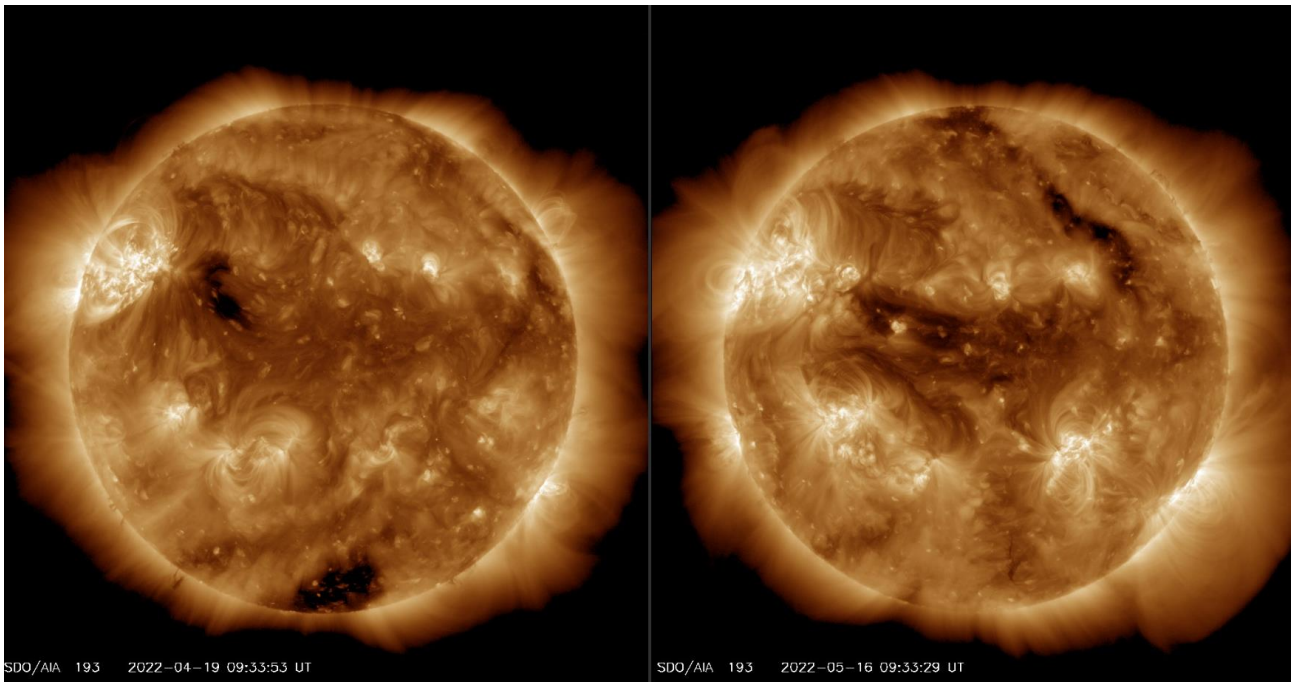

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Figure 3: Enlil Forecast, showing arrival of fast winds at

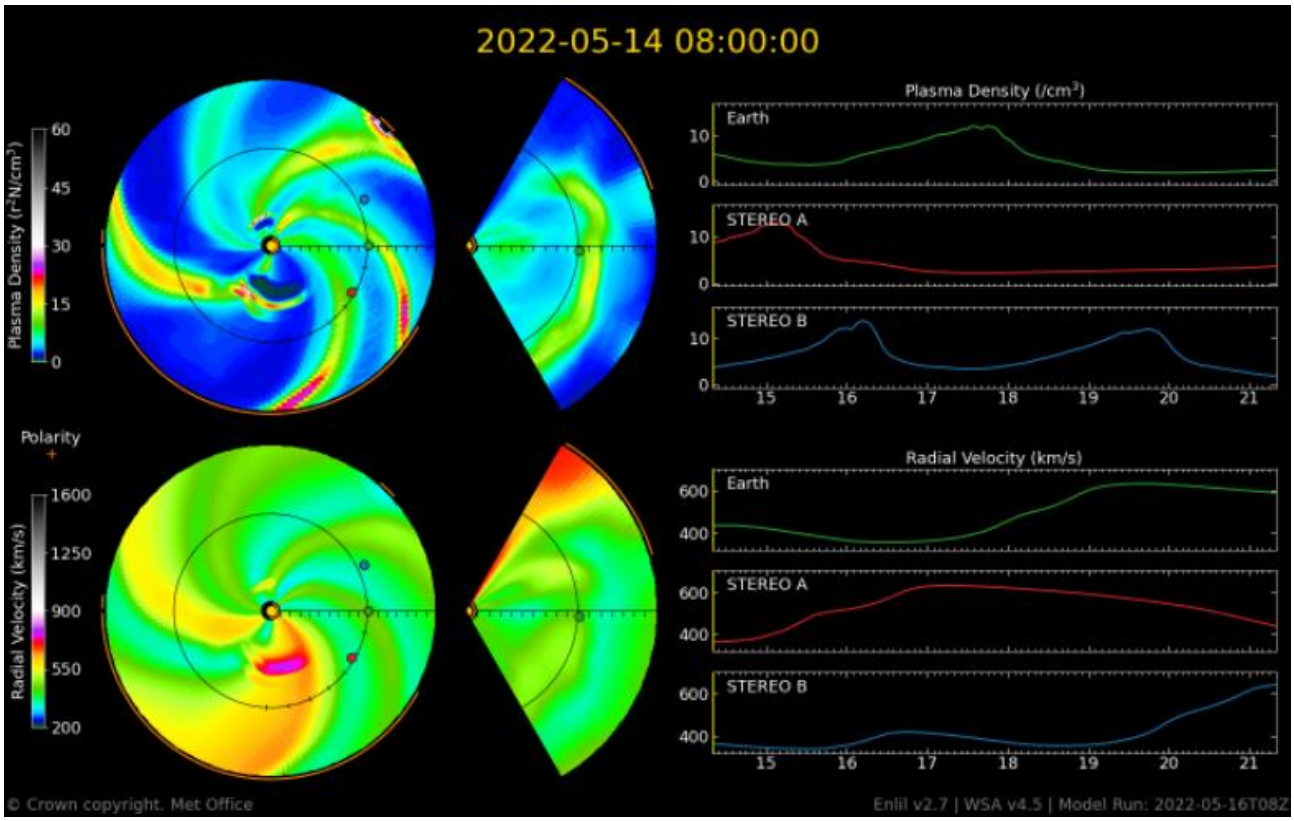
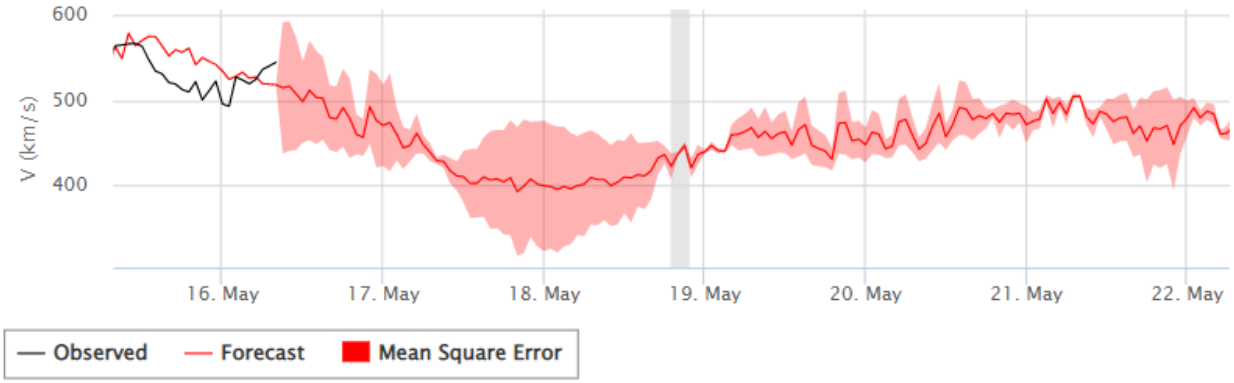


Figure 4: MOSWOC Persistence forecast, showing slight increase on 19th.



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Radio Blackouts - X-Ray Flares:

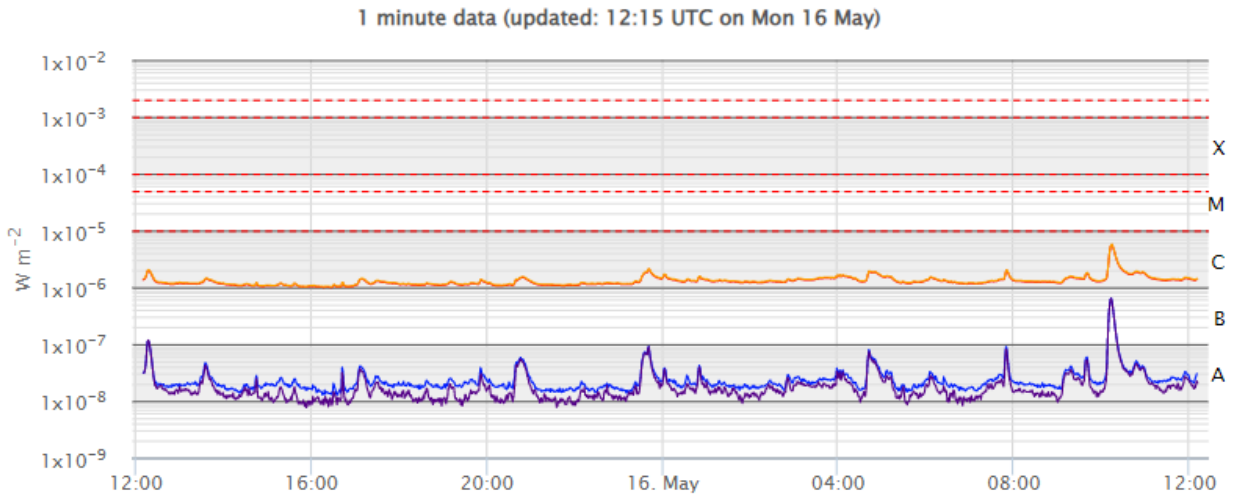
Solar Activity is currently Low with recent C5.6-flare from new sunspot regions in the northeast disc, with six numbered sunspot regions and two unnumbered regions on the Earth-facing Sun.

The largest region, and likely source of notable flaring is AR3007 Esi/Beta, however this region currently appears stable with a relatively simple bipolar structure. Further regions of note include AR3010 Eai/Beta, AR3014 Dao/Beta and AR3015 Dso/Beta, however only AR3014 is currently showing any sign of growth with all regions relatively stable. Further regions are also likely to rotate onto the disc during the period, with looping visible on STEREO A-euvi imagery beyond the west limb.

Low activity is expected to persist, with a daily chance of isolated M-flares potentially increasing activity to Moderate. This risk increasing later in the period, with any far-sided regions that rotate onto the disc. There is a very slight chance of X-flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 5: GOES-16/17 X-ray Flux



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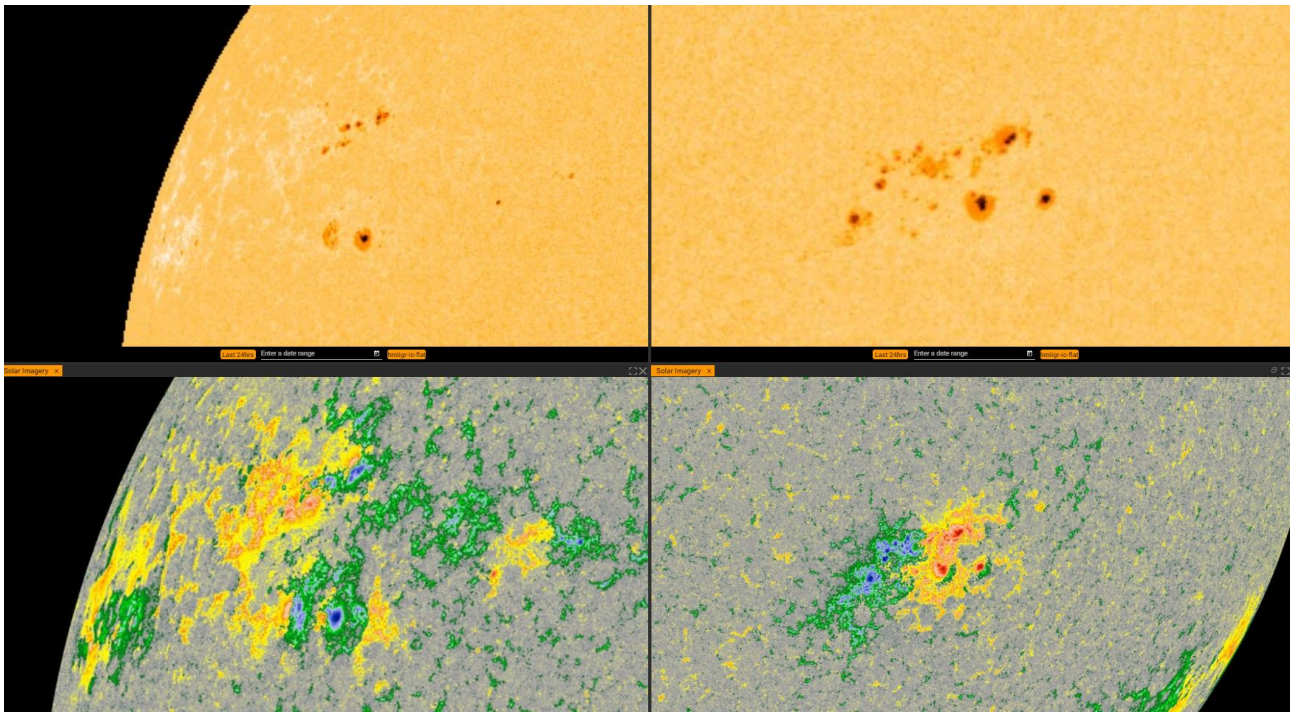
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is at background levels and is expected to remain at that level throughout the period. However, there is a slight chance of an S1 or greater event during the forecast period, primarily due to AR3007 as it transits westwards towards the western limb of the visible disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 6: SDO Intentensitygram and Magnetogram of various regions in NE, along with AR3007 in the SW.



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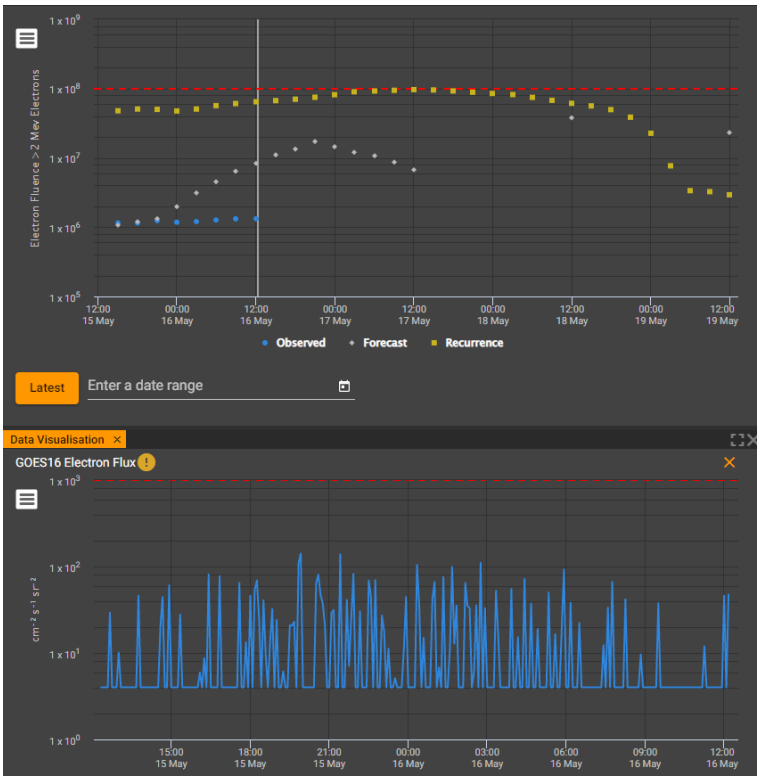
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) as measured by GOES-16 at GEO is currently at background levels, but may rise to Moderate levels over the next few days due to fast wind influence from CH81/+ . Any potential enhancement to the solar wind environment from CH82, most likely day 3, could then increase flux levels to Moderate to High day 4 (19th).

The corresponding electron fluence is therefore expected to show an upward trend through the period, however on balance will most likely continue below the Active (1e8 integrated pfu) threshold. This is reflected by current REFM output and in the probabilities table above.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 7: GOES-16 >2MeV Electron Flux and associated fluence with REFM



NOTE: Our REFM model has been upgraded and has changed in appearance. The two main changes are the option to include a recurrence graph, which superimposes observations from the last solar rotation onto the current solar rotation (each plot is the observation from T-minus 28 days). Recurrence is used as a guide to what can be expected in the coming days assuming no difference in solar features, and has low accuracy in certain situations but good accuracy in others (such as recurring coronal holes). The other change is the cadence of REFM forecast fluence data has been reduced past day 1 to only one value per day. The cadence remains 3-hourly for the first 24 hours.

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